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ABSTRACT

Eighty first-grade students, randomly selected from eight elementary schools, participated in this study. Four of the schools were located within the city and four in the rural area surrounding the city. The assessment instrument was the Organisms Evaluation Supplement, designed to evaluate students' attitudes in science, students' perception of the classroom environment, and how well students are achieving the specified cognitive objectives of the unit. The instrument was administered as a pretest and a posttest to all students. The treatment consisted of instructing the students in the "Organisms" unit of the Science Curriculum Improvement Study (SCIS) program. Significant positive change in pupil performance as a result of instruction was found. The gain scores were subjected to a t-test at the .05 level. No pretest or posttest differences were found when examining urban versus rural populations. It was concluded that the "Organisms" assessment instrument is effective in terms of content validity, reliability, objectivity and interest. (Author/EB)

THE EFFECTIVENESS OF THE CONCEPT/PROCESS SECTION OF THE ASSESSMENT INSTRUMENT FOR THE SCIENCE CURRICULUM IMPROVEMENT STUDY FIRST GRADE BIOLOGICAL SCIENCE UNIT ENTITLED "ORGANISMS"

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Introduction

The Science Curriculum Improvement Study elementary science program is one of several curriculum development projects which were funded by the National Science Foundation. The program is organized around a conceptual framework which is bound together by the processes of science. The main objective of the program is to produce students who are scientifically literate.

Most of the evaluation of the project which has been done has been to insure proper construction of the units. In 1970, an evaluation device was designed by the developers that would enable classroom teachers to evaluate student progress in the program. At the time of this study no data was available on the effectiveness of this classroom assessment instrument.

Statement of the Problem

What is the effectiveness of the Concept/Process section of the assessment instrument for the Science Curriculum Improvement Study first grade biological science unit entitled "Organisms"?

Assumptions and Limitations of the Study

This study was delimited to eight first grade classrooms in the Chambersburg Area School District, Chambersburg, Pennsylvania. The researcher was not the regular classroom teacher of the students, therefore the students may have been reluctant to respond to the questions of the researcher.

Students were removed from their classrooms for individual testing. This may have created a stress situation which could have affected their responses.

Delimitations of the Study

The researcher assessed only the Concept/Process section of the S. C. I. S. instrument in terms of content validity and reliability. The attitudes in science and the perception of classroom environment sections of the assessment instrument were not included in this study.

It was assumed by the researcher that because of the student oriented nature of the Science Curriculum Improvement Study program, teacher differences would not be a threat to the validity of the study.

Hypotheses

1. The Concept/Process section of the assessment instrument for the "Organisms" unit of the Science Curriculum Improvement Study program is effective in terms of content validity and reliability.

2. There is a positive change in pupil performance between a pre-test and a post-test of the Concept/Process section of the "Organisms" assessment instrument.

3. There is no significant difference in pupil performance on the Concept/Process section of the "Organisms" assessment instrument between pupils in rural schools and those in urban schools.

Sample

The sample was limited to first grade students in the Chambersburg Area School District who were receiving instruction in the S. C. I. S.

elementary science program. Ten students, five girls and five boys, were selected at random from the first grade classes of each of eight elementary schools in the district. The random selection of subjects for the sample groups was done by the researcher from class lists supplied by the teachers. A total of eighty first grade students were chosen for participation in the study.

The schools were selected on the basis of geographical location. Four of the cooperating elementary schools were located within the city of Chambersburg, a city of approximately 25,000 people located in the rural Cumberland Valley of Pennsylvania. Four were schools in the rural area surrounding Chambersburg.

Design of the Instrument

The S. C. I. S. first grade biological science unit is entitled "Organisms." The assessment instrument for this unit was prepared for S. C. I. S. by Knott, Lawson, and Peterson.[1] The instrument is divided into three areas of pupil assessment.

The first area is designed to evaluate students' attitudes in science. Four desired attitudes are examined. These attitudes are: curiosity, inventiveness, critical thinking, and persistence.

The second section of the assessment instrument is designed to evaluate the students' perception of the classroom environment. Pupils are given an opportunity to express their feelings about the science activities they have completed.

The third section of the instrument is the Concept/Process evaluation section. This section consists of five activities which

seek to evaluate how well students are achieving the specified cognitive objectives of the "Organisms" unit. Activity one, "Identifying Requirements for Plant Growth," assesses the children's abilities to identify and describe requirements necessary for seed germination and plant growth. Activity two, "Describing Events in Aquaria," assesses the children's abilities to describe events that occur in aquaria: feeding, birth, hatching, growth, death, and decay. Activity three, "Identifying Organisms and Habitats," assesses the children's abilities to identify pictures of organisms and habitats and to associate specific organisms with specific habitats. Activity four, "Diagramming Food Webs," assesses the children's abilities to construct food webs. Activity five, "Discussing Experiments," assesses the children's abilities to pose hypotheses, suggest experiments for testing hypotheses, and drawing conclusions from experimental data.[2]

Activites one, two, and five of the Concept/Process section of the instrument were administered to members of the sample groups as individual tests while activities three and four were given as group tests.

Procedures for Gathering Data

The Concept/Process section of the organisms assessment instrument was administered by the researcher as a pre-test and a post-test to all students included in the study. Only one evaluative activity was administered to the students in a given sitting. Teachers who were participating in the study agreed to follow the schedule outlined in the Organisms Teachers Guide. Pretests were administered to the sample groups during the weeks January 15 to January 31.

At the conclusion of the pre-test the teachers began instructing the students in the "Organisms" unit of the S. C. I. S. program. As each section of the "Organisms" unit was completed, teachers contacted the researcher and a time was arranged to administer the corresponding section of the post-test.

The pre-test scores of students in the rural and urban groups were subjected to a t test which indicated that there were no differences in the beginning operational levels of the groups before they were subjected to the treatment.

The treatment consisted of instructing the students in the "Organisms" unit of the S. C. I. S. program. The pre-test and post-tests were administered in the same manner.

The pre- and post-test scores of both the rural and urban groups were then compared to determine if a positive change in pupil performance had occurred. Gain scores were calculated for the rural and urban groups and a t test of difference was applied to the scores.

Reliability for the post-test scores Concept/Process section of the assessment instrument was determined by the split half method using the Spearman-Brown formula.[3]

Content validity was established by comparing the Concept/Process objectives in the "Organisms" teachers manual to the test items of the Concept/Process section of the assessment instrument. This was done by two first grade teachers who had taught the Organisms unit, one Science educator, and the researcher.

Post-test scores for students in rural and urgan groups were subjected to a t test of difference to determine if there was a

significant difference between rural and urban pupil performance on the post-test.

Method of Analysis of Data

The pupil responses for both pre-test and post-tests were tabulated. The items were listed on pre-test and post-test master sheets for each school according to the order in which they appear on the evaluation instrument. The items were numbered from one to forty-one. A correct response for each item was given the value of one point.

The number of students participating in the study was eighty. Pre-test data were based upon this number. However, during the course of the study three mortalities resulted in the rural population. Therefore post-test scores and gain scores were computed on the basis of a population of seventy-seven pupils.

The pre-test scores for pupils in rural and urban schools were subjected to a t test of difference. Calculation showed that the urban mean for the pre-test was 11.4 with a standard deviation of 2.57 and the rural mean for the pre-test was 11.6 with a standard deviation of 3.10. (See Table 1.) In a comparison of the rural and urban pre-test scores the calculated value of t at the .05 alpha level was 0.353 with 78 degrees of freedom. This value was smaller than the necessary $2{,}000^{4}$ value as taken from statistical tables. Therefore, one can infer that no significant difference exists between the pre-test scores of rural and urban students. It was assumed, therefore, that students were at

Table 1

Pre-Test and Post-Test Mean Scores
and Mean Gain Scores for all
Schools in the Population

	School	N	Pre-Test Mean	N	Post-Test Mean	Mean Gain
	URBAN					
I.	School A					
	Boys	5	10.4	5	26.8	16.4
	Girls	5	10.4	5	27.8	17.4
	Total	10	10.4	10	27.3	16.2
II.	School B					
	Boys	5	13.0	5	25.8	12.8
	Girls	5	11.0	5	24.8	12.2
	Total	10	12.0	10	25.3	13.3
III.	School C					
	Boys	5	12.6	5	27.4	14.8
	Girls	5	14.0	5	28.8	14.8
	Total	10	13.3	10	28.1	14.8
IV.	School D					
	Boys	5	10.8	5	28.6	17.8
	Girls	5	9.0	5	28.2	19.2
	Total	10	9.9	10	28.4	18.5
URBAN TOTAL		40	11.4	40	27.2	15.8

NOTE: Table 1 continued on next page

Table 1 (continued)

	School	N	Pre-Test Mean	N	Post-Test Mean	Mean Gain
	RURAL					
I.	School E					
	Boys	5	12.8	5	32.0	19.2
	Girls	5	12.4	5	27.4	15.0
	Total	10	12.6	10	29.7	17.1
II.	School F					
	Boys	5	8.4	5	26.8	18.4
	Girls	5	10.0	4	28.0	18.2
	Total	10	9.1	9	27.3	18.4
III.	School G					
	Boys	5	12.2	5	26.4	14.2
	Girls	5	11.8	5	25.2	13.4
	Total	10	12.0	10	25.8	13.8
IV.	School H					
	Boys	5	11.4	3	22.3	11.0
	Girls	5	14.4	5	27.6	13.2
	Total	10	12.9	8	25.6	12.3
RURAL TOTAL		40	11.6	37	27.1	15.4
TOTAL POPULATION		80	11.5	77	27.2	15.6

approximately the same level of performance on the pre-test items prior to being given instruction in the "Organisms" unit.

Analysis of Data

Hypothesis number one: The Concept/Process section of the assessment instrument for the "Organisms" unit of the Science Curriculum Improvement Study is effective in terms of content validity and reliability.

In order to determine the content validity of the instrument, copies of the Concept/Process section of the assessment instrument and a copy of the "Organisms" Teacher's Guide were supplied to two first grade teachers in the Chambersburg School District. These teachers had taught the S. C. I. S. "Organisms" unit. In addition, a copy of the assessment instrument and an "Organisms" Teacher's Guide were inspected by a science educator and the researcher. These four individuals compared the specific objectives within the teacher's guide with the items on the evaluation instrument. A consensus of the four opinions was used to derive a single statement of content validity by the researcher. That statement is as follows: the items of the Concept/Process section of the assessment instrument for the "Organisms" unit of the S. C. I. S. program are consistent with the objectives of the Organisms Teacher's Guide. The instrument, therefore, is considered to be valid.

To determine the reliability of the Concept/Process section of the "Organisms" assessment instrument, only the scores of the post-test were used. The test items were split into two groups, A and B. The

test items were split into two groups, A and B. The items were paired according to equivalent difficulty, as determined by the researcher. Each test paper was then assigned two groups of scores. A Pearson product-moment correlation coefficient was computed for the two sets of scores. This was found to be .405. The Pearson product-moment correlation obtained was equivalent to a test one half the length of the test used.

Using the Spearmen-Brown formula, an r of .577 was obtained. This is considered to be significant. The Concept/Process section of the "Organisms" assessment instrument is therefore considered to be a reliable test.

Since the "Organisms" assessment instrument was found to be both valid and reliable, the first hypothesis of this study must be accepted.

Hypothesis number two: There is a positive change in pupil performance on the Concept/Process section of the "Organisms" assessment instrument from pretest to post-test.

To test this hypothesis gain scores were computed for each student. The total mean gain for the population of seventy-seven students is 15.4. The results are shown in Table 1. It is apparent that the gain scores are significant when a t test is applied. At the .05 alpha level with 76 degrees of freedom, a calculated value for t was found to be 35.1. Since this is more than the 1.67 needed to prove significance, the positive change in pupil performance is considered to be highly significant. Thus the second hypothesis of this study cannot be rejected.

Hypothesis number three: There is no significant difference in pupil performance on the Concept/Process section of the "Organisms" assessment instrument between pupils in rural and urban schools.

To test this hypothesis, the post-test scores of the students in rural and urban schools were subjected to a t test of difference. (See Table 1 for post-test scores.) Statistical analysis of these scores indicates the calculated t value at the .05 alpha level with 75 degrees of freedom as being 0.23. Since this is smaller than the 2.000 level necessary to establish a significant difference, the hypothesis cannot be rejected. Therefore, the researcher concluded there was no significant difference between rural and urban pupil performance on the post-test.

Conclusions

The Concept/Process section of the assessment instrument of the "Organisms" unit of the S. C. I. S. program was found to be both valid and reliable. It can be considered to be an acceptable method of evaluating the degree to which pupils are attaining the specific objectives of the "Organisms" unit of the S. C. I. S. program.

Since there was a significant improvement in pupil performance, it can be inferred that the students within the population had obtained some of the specific goals established in the "Organisms" unit. Inspection of the data sheets revealed that students were able to describe requirements for plant growth, describe events in aquaria, identify organisms and habitats, associate specific organisms with specific habitats, and construct food webs. Forty-four out of the

total population of seventy-seven were able to suggest an acceptable hypothesis for a problem on the post-test. However, only sixteen out of the seventy-seven were able to interpret the results of an experiment. No child in the population was able to suggest an experiment to test his hypothesis.

In addition, children appeared to have difficulty in suggesting an approximate time which was required for the germination of seeds. Children also had difficulty in recognizing seeds as organisms. Only seventeen out of the population of seventy-seven were able to do this.

The food web also presented problems for students. Children had difficulty in identifying the correct feeding relationships. Forty-seven out of the seventy-seven students correctly identified the pattern. Many students had difficulty using arrows to identify the feeding relationships. However, fifty-two students did use the arrows correctly.

Implications

From the results of the study the researcher concluded that the the "Organisms" assessment instrument is an effective test in terms of content validity, reliability, objectivity, and interest. The students observed by the researcher retained a high degree in interest throughout the testing program.

Because of the activity oriented nature of the instrument, the students did not seem to regard it as a test. They responded in much the same way one would expect them to during a show and tell experience. Teachers within each school informed the researcher that students

looked forward to his visit.

The first four activities can be considered objective in nature. Either a student displayed an observable behavior or he did not. The evaluator has only to make a yes or no decision. However, the fifth activity requires subjective judgment on the part of the evaluator. A decision must be made as to whether or not the student has suggested an acceptable hypothesis, interpreted data satisfactorily, and designed an appropriate experiment. These interpretations may vary with the standards of the evaluator.

The study indicated that there was no significant difference between the post-test scores of students in the urban and rural schools of the population. Chambersburg is located in a rural setting, the Cumberland Valley of Pennsylvania. It is possible that students in both urban and rural schools had similar backgrounds. For this reason, it is difficult to generalize this data beyond the limits of the population. More research is needed to determine the effect of the "Organisms" unit on students of greatly divergent backgrounds.

It was noted in the conclusion that students had difficulty with several items on the test. It was noted that students had difficulty in hypothesizing, interpreting data, and constructing experiments. All three require advanced levels of abstraction. Most first grade students are at a concrete level of operation. Perhaps it is asking too much for these abilities to be developed after a one-year exposure to the S. C. I. S. program. As stated in the overview, these are "long range goals of the S. C. I. S. program."[5] Students should be expected to begin to exhibit these abilities the fourth year of their involvement in the

program. Further testing is needed to determine when these abilities become apparent.

Children also failed to respond adequately to the item dealing with the time needed for seeds to germinate. Children of this age group are still formulating their concept of time. It was apparent from responses, which varied from seven weeks to two months, that not all students in the study had yet developed a concept of time.

The items dealing with food webs also presented problems for many students. These items required students to transfer information to a new situation. Again, this is perhaps an activity which requires abstraction beyond the level of first grade students.

One of the basic assumptions of this study was that the materials in the "Organisms" unit were child centered. Therefore, teacher differences were not considered to be important. This assumption is in question. The researcher supplied four sets of guppies to one of the schools participating in the study. Each time the guppies died. An investigation into the procedure used by the teacher to set up the aquaria revealed that she had washed the tanks with detergent. The resulting soap residue had killed the guppies. After the situation was corrected, the class proceeded without further incident.

In a second class it was discovered that a teacher was afraid to give the students the responsibility of feeding the fish. As a result, some students were not sure what fish ate.

The researcher also noted that the Chambersburg district had a problem with supplying the teachers with live materials for the "Organisms" unit. In four out of eight schools in the study, teachers were

not supplied with adequate live materials to teach the program. As a result, the researcher supplied live materials where needed.

Recommendations

It is recommended by the researcher that, based upon the results of this study, the first grade teachers within the population should be supplied with the "Organisms" assessment instrument. The instrument would be helpful in aiding teachers to determine how well their students were achieving the specific objectives set forth in the Organisms Teacher's Guide.

The researcher feels that portions of the assessment instrument need to be altered or deleted. Part five, in particular, contains test items which appear to be dissonant with the expected developmental level of first grade children. If not deleted, teachers should be warned about placing too high a value on these items.

It is also recommended that a program of in-service instruction in science education be established for teachers within the Chambersburg district who are teaching the S. C. I. S. program. This would improve teachers' backgrounds and techniques of instructing the program. In particular, teachers need information of the care of organisms. In addition, in-service sessions would provide an opportunity for an exchange of ideas among the teachers involved.

It is a further recommendation of this study that a science coordinator be employed by the Chambersburg School District. The coordinator should be placed in charge of teacher in-service education

in science teaching. In addition, he should supervise the maintenance of the science materials which are necessary to properly operate the S. C. I. S. program.

FOOTNOTES

[1]Robert C. Knott, and others, Organisms Evaluation Supplement (Berkeley, California: Regents of the University of California, 1972).

[2]Ibid.

[3]Robert L. Ebel, Measuring Educational Achievement (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1965), 447.

[4]Sir Ronald A. Fisher and Frank Yates, Statistical Tables for Biological, Agricultural, and Medical Research (New York: Hafner Publishing Company, Inc., 1963), 46.

[5]Knott, op. cit., Activity 5.